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Original Article

Comparison of P-Possum and Esas (Emergency Surgery Acuity Score) For Prediction of 30-Day Mortality in Patients Undergoing Emergency Laparotomy

Paras Ibn E Ali, Sohail Ilyas, Sohaib Ashraf*, Hamayal Zafar*,Farwa Kazmi*, Ubaid Ullah Siddiqui

Department of Surgery, Combined Military Hospital Quetta/National University of Medical Sciences (NUMS) Pakistan, *Department of Surgery, Combined Military Hospital Rawalpindi/National University of Medical Sciences (NUMS) Pakistan

ABSTRACT

Objective: To evaluate the validity of the Portsmouth Physiological and Operative Severity Score for the enumeration of Mortality and morbidity (P-POSSUM) and Emergency Surgery Acuity Score (ESAS) scoring system and compare the positive predictive value of both in predicting 30 days' mortality in patients undergoing emergency laparotomy.

Study Design: Prospective longitudinal study.

Place and Duration of Study: Department of Surgery and Department of Accident and Emergency, Combined Military Hospital Rawalpindi, Pakistan from Aug 2021 to Mar 2022.

Patients and methods: A total of 210 patients were enrolled in the study, with 30-day post-operative mortality as the primary outcome of interest. P-POSSUM and ESAS scores were calculated for all patients upon presentation to the surgical emergency. A cutoff of 19 for ESAS and 63 for P-POSSUM was used to predict 30-day post-operative mortality in emergency laparotomy patients.

Results: The observed mortality rate among the recruited patients was 9.5%. The mean age was 46.24±11.13 years, with 62.4% of the population being male. Among those who died within 30 days of follow-up, the majority were aged over 50 years (p=0.002) and predominantly male (p=0.460), with most having ileal or jejunal perforation. The AUROC for ESAS in predicting 30-day post-operative mortality was 0.974, while for P-POSSUM it was 0.885.

Conclusion: ESAS and P-POSSUM can both be employed in emergency surgical situations. As ESAS can be calculated pre-operatively, it should be preferred over P-POSSUM.

Keywords: Emergencylaparotomy, Esas, P-Possum, Surgical mortality.

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INTRODUCTION

Emergency general surgery (also known as EGS) carries a higher mortality and morbidity risk than elective surgery. The overall mortality and morbidity rate in the United States is disproportionately high, despite the fact that EGS only accounts for 7.1 percent of all hospitalizations in the country.[1] In order to optimize clinical practice, it is necessary to stratify risks accurately and assign scores to those risks. Additionally, it is important to have the ability to predict operative mortality and morbidity.[2]

Surgical complications increase the risk of death and shorten a patient's life expectancy. Patients with preexisting illnesses, such as cardiovascular disease and functional limitations, are more likely to experience difficulties following surgery. An accurate risk stratification could help patients make more educated decisions about their surgeries by identifying those, most likely to benefit from certain perioperative therapies and reducing the number of patients who do not receive them. An objective, reliable, cost-effective, and easily administered clinical risk score system based purely on preoperative information would be beneficial for patients having elective and emergency surgery.[3]

Among the several surgical risk assessment systems available today, one is called the Physiologic and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM) model.[4,5] POSSUM was developed to predict in-hospital mortality and morbidity after surgery by making use of scores relating to a total of twelve physiological variables as well as six operative variables. On the other hand, it was later discovered that POSSUM overestimated the likelihood of postoperative mortality, particularly in patients who were at low risk. This resulted in a modification that Whiteley[6] and his colleagues came up with called the Portsmouth modification (P-POSSUM).

Risk scoring systems for large populations and populations with a variety of pathologies were

Correspondence: Dr Paras Ibn E Ali, Department of Surgery, Combined Military Hospital Quetta Pakistan

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initially developed. It was also used for patients who had only one diagnosis or one type of operation, but this became less common. Emergency laparotomies are associated with a significant risk of morbidity and mortality; however, it is unknown whether any of the two surgical risk rating methods can assist in predicting this risk.[7] Using crude mortality as an outcome measure for surgical patients is fundamentally deceptive in a demographically complex population. However, meaningful comparisons need correct risk classification of the patients under research before any conclusions can be drawn about the reported outcomes. Predictions of mortality and morbidity are routinely used to rationalize the use of high-risk surgery in emergency rooms, making accurate risk prediction crucial.[8]

METHODOLOGY

A Prospective longitudinal study was conducted in the department of Surgery, CMH hospital, Rawalpindi after the approval from the head of department and institutional review board (ERC No. 254 dated 10th August 2021). The study was conducted from Aug 2021 to March 2022. A total of 210 patients were enrolled in the study. Sample size was calculated using WHO sample size calculator, keeping the confidence level at 95%, with margin of error as 06%. The minimum sample size came out to be 167. Patients undergoing emergency laparotomies in our facility were enrolled in this study to evaluate the validity of the P-POSSUM and ESAS scoring system and to compare the positive predictive value of both in predicting 30 days' mortality.

Inclusion criteria: The patients of either gender, aged 15 to 70 years admitted for an emergency laparotomy in general surgery emergency were included in the study.

Exclusion criteria: Patients who were unable to undergo general anesthesia, those who needed cardiopulmonary resuscitation prior to surgery, and those who were mentally disabled or younger than fourteen years old were excluded from the study.

All study participants consented to participate in the study. Standard procedures were used to gather pertinent medical history and conduct necessary investigations while the patient was in the hospital. A proforma sheet was used to keep record of the physiological and intraoperative findings of the patients, and a mortality rate was then calculated. P-POSSUM and ESAS scores were calculated for the all the patient at the time of presentation in the surgical emergency. Cut off value of 19 was taken for ESAS for predicting mortality; and a cut off of 63 was taken for P-POSSUM. The death and morbidity rates at 30 days were the key outcomes of interest that were evaluated.

Data of both the P-POSSUM and ESAS scoring were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 23. Frequency and percentages were calculated for categorical variable and mean with standard deviation for the continuous variables. Positive predictive value of both the criteria was calculated and compared.

RESULTS

Analysis of data showed that the mean age of the patients was 46.3+11.1 years, most of them were of age 31 to 50 years. Male and female ratio was around 3:2, Males 131(62.4%) and females 79(37.6%). Among all these patients of emergency laparotomy, majority of the patients were diagnosed as having appendicular perforation 84(40%), details are shown in the Table-I.

Table-I: Demographic characteristics of the Patients (n=210)

Variables		n(%)	Mortality		*p*-value
			No (Alive)	Yes (Dead)	
Age Group	Less than 30	11 (5.2%)	11 (5.2%)	0 (0%)	0.001
	31 to 50	143 (68.1%)	141 (67.1%)	2 (0.9%)	
	more than 50	56 (26.7%)	38 (18.1%)	18 (8.6%)	
Gender	Female	79 (37.6%)	73 (34.8%)	6 (2.8%)	0.460
	Male	131 (62.4%)	117 (55.7%)	14 (6.7%)	
Indication of surgery	Appendicular perforation	84 (40%)	83 (39.5%)	1 (0.5%)	0.669
	DU perforation	55 (26.2%)	54 (25.7%)	1 (0.5%)	
	Ileal perforation	28 (13.3%)	17 (8.1%)	11 (5.2%)	
	Intestinal obstruction	39 (18.6%)	35 (16.7%)	4 (1.9%)	
	Jejunal Perforation	4 (1.9%)	1 (0.5%)	3 (1.4%)	
	n	Minimum	Maximum	Mean+SD	
Age	210	24.00	90.00	46.24+11.13	
P-POSSUM	210	20.00	87.00	37.29+16.37	
ESAS	210	2.00	24.00	11.60+5.57	

Actual mortality was 9.5%, seen among 20 of total 210 patients. Among the patients who died in 30 days of follow-up, majority were of age more than 50 years (p=0.002), male gender (p=0.460), ileal or jejunal perforation.

Positive Predictive Value of ESAS was better than that of P-POSSUM. ROC curves were also plotted for both these scoring systems and area under the ROC curve was calculated. AUROC for ESAS was 0.974 (AUROC of 0.974, SE = 0.014, CI 95%, lower: 0.94, upper 1.0) (Figure-1) and that for P-POSSUM prediction of post-operative mortality in 30 days was 0.885 (AUROC of 0.885, SE = 0.055, CI 95%, lower: 0.77, upper 0.99) (Figure-2), while O/E ratio for ESAS and P-POSSUM was 0.83 and 0.74, with a significant p-value (p=0.001). This shows that both of these score slightly over predict, but the ESAS can be of more value because of its better positive predictive value and AUROC. Both had Sensitivity of 85% ESAS and PPOSSUM; Specificity 96.3% and 94.7% and Positive predictive value 70.8% and 62% (Table-II).

Table-II: Predicted Mortality and Cumulative Analysis of ESAS and Portsmouth Physiological and Operative Severity Score (n=210)

		Predicted Mortality by P-POSSUM		Total
		Yes	No	
Actual Mortality	Yes	17(8.09%)	3(1.43%)	20(9.52%)
	No	10(4.76%)	180(85.71%)	190(90.48%)
Total		27(12.86%)	183(87.14%)	210(100%)
			p-value < 0.001	
		Predicted Mortality by ESAS		Total
Actual Mortality	Yes	17(8.09%)	3(1.43%)	20(9.52%)
	No	7(3.33%)	183(87.14%)	190(90.48%)
Total		24(11.43%)	186(88.57%)	210(100%)
			p-value < 0.001	

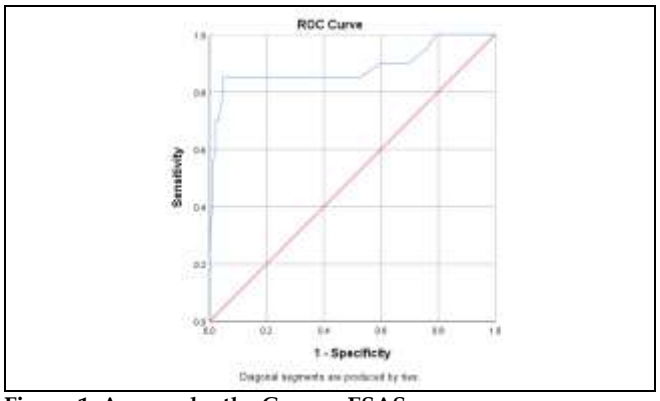

Figure-1: Area under the Curve – ESAS

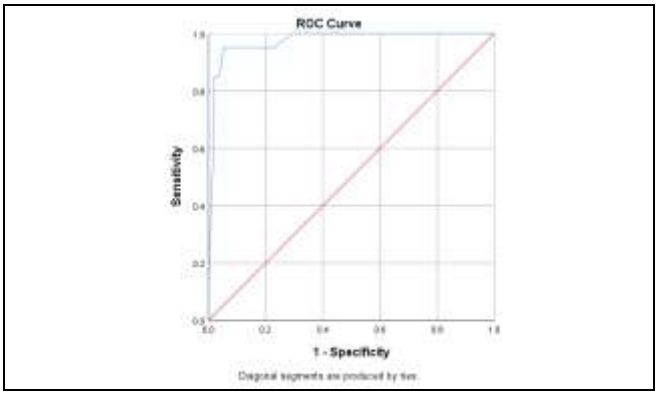

Figure-2: Area under the Curve Portsmouth Physiological and Operative Severity Score

DISCUSSION

In our study the actual mortality was 9.5% among the patients who died in 30 days of follow-up, majority were aged more than 50 years with male predominance, having ileal or jejunal perforation. PPV of ESAS was better than that of P-POSSUM and ROC curves analysis showed AUROC for ESAS of 0.974 and for P-POSSUM 0.885. Observed / expected (O/E) ratio for ESAS and P-POSSUM was 0.83 and 0.74, with a significant p value (p = 0.0001). This shows that both these scores slightly over predict, but the ESAS can be of more value because of its better positive predictive value, AUROC and O/E ratio.

The Emergency Surgery Score, also known as the ESAS now named as ESAS (Emergency Surgery Acuity Score) is a novel preoperative risk assessment tool that was developed in the year 2016 for patients undergoing emergency general surgery.[9] Since its introduction, ESAS has been able to accurately predict not only death rates but also complication rates and the need for postoperative hospitalizations to the intensive care unit (ICU).[10,11] The hypothesis that ESAS is a valid indicator of postoperative outcomes was supported by the findings of the most recent prospective multicenter trial. These outcomes include mortality and morbidity within the first 30 days after surgery, in addition to the need for hospitalizations to the intensive care unit (ICU).[12]

P-POSSUM was validated in a study utilizing ROC curve analysis with a cut off value of 63 to predict death; the area under the curve was 0.989. P-POSSUM had a 98.1 percent overall predictive value with an OR of 1.364, a 95 percent CI of 1.193-1.559, and a P 0.001. The computed sensitivity of P-POSSUM was 91.3 percent, and the specificity was 99.3 percent.[13]This was slightly different from that reported in our study.

Sangni NF, *et al.,* validated the ESAS in predicting 30 days mortality among surgery patients. It was reported that in the validation phase, the mortality rate was around 7%, and the ESAS C-statistic stayed at 0.86 (OR of 1.318, 95%CI of 1.140–1.524, and a $p<$ 0.0001); % observed mortality 50% and percentage predicted mortality was 59%.9 The O/E ratio for ESAS was similar to that reported in our study. Moreover, in a Brazilian tertiary hospital, 551 Laparotomies mostly colorectal surgery patients were enrolled to compare expected and observed morbidity and mortality. The POSSUM analysis predicted morbidity more accurately (39.2% vs. 15.6%) and P-POSSUM accurately predicted mortality, unlike POSSUM. The overall expected and observed mortality was similar (5.8% x 5.6%).[14] Our study compared ESAS and P-POSSUM for predicting post-operative Mortality, which showed that both slightly over predicted but ESAS was more close to observed value.

The discrimination ability of P-POSSUM and POSSUM was outstanding in predicting death in a study examining multiple scores for prediction of post-operative mortality and morbidity. Morbidity was 15.4 percent after 30 days. The rate of re-intervention was 2.1 percent, while the death rate was 2.1 percent. In forecasting mortality, the discrimination ability was outstanding.[15] In another study, a proforma sheet was used to score emergency laparotomy patients at a tertiary hospital's surgery department. Pre- and intra-operative physiological scoring was performed, and patients were followed for 30 days after surgery. The rates of mortality were observed and predicted. Using linear analysis, an observed-to-expected ratio of 1.18 predicted a negative post-operative outcome. The mortality rate was comparable p=0.833). Across all risk factors, higher POSSUM scores were associated with death. POSSUM predicts the post-op outcome of emergency laparotomies.[16]

In a 15-month study on ESAS assessment, all emergent laparotomy patients were prospectively included. The overall 30-day patient mortality rate was 16% and the ESAS predicted mortality, morbidity and ICU admission.[17] However, our study only collected and analyzed data of 30 days mortality.

An international database of emergency surgeries of 2011-2012 reported after multivariate and univariate analysis to identify the ESAS components that were most likely to cause problems. 38% cases had at least one complication in the first 30 days of treatment. At scores of 0, 7, and 15, the probability of a 30-day complication rose from 7% to 53% to 91%, respectively. Complications peaked at 92 percent for those who scored at least[15]. Perioperative patient and family counseling and patient triage could both benefit from such a score.[18] Mortality and morbidity rates following ESAS were 8.2% and 31.7 %, respectively, in a study. In 40% and 98% of cases, ESAS accurately predicted the need for ICU admission, respectively, by taking a cut-off score of 9 and 16. Predictive value for ICU admission at cutoff of 15 was 90%, according to the study. ESAS can be used as an ICU triage tool in resource-limited settings to rescue clinically deteriorating patients and avoid unnecessary admissions to the hospital.[19]

The ESAS predicts patient mortality using only preoperative factors, unlike SRS and P-POSSUM. ESAS does not include subjective characteristics like ASA class in P-POSSUM or SRS. This partly explains ESAS's superior discrimination over ASA. ESAS gives doctors and patients vital information when discussing emergency procedures.[20]

Emergency laparotomy is a common procedure, particularly in tertiary care settings. In our patient population undergoing emergency laparotomy, scores such as ESAS and P-POSSUM can accurately predict mortality and morbidity. These scores assist surgeons in providing better preoperative patient/attendant counseling, risk stratification, quality benchmarking, and predicting postoperative complications and mortality. Both ESAS and P-POSSUM can be used in emergency surgical situations because they predict mortality equally well; however, because ESAS only accounts for pre-operative parameters, its utility is more timely and efficient.

LIMITATION OF STUDY

The most significant limitations of the study was a limited sample size along with a single location for the research. Additionally, the researchers did not attempt to estimate late and long-term effects of surgery and general anesthesia, which can be a cause of mortality.

CONCLUSION

While we found that both scores somewhat over predict, the ESAS has a higher positive predictive value, AUROC, and O/E ratio, making it a more useful tool. In urgent surgical scenarios, ESAS and P-POSSUM can be used for preoperative patient counselling, risk classification, quality benchmarking, and postoperative patient triage. Since ESAS can be determined before surgery, it is the preferable method over P-POSSUM.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

PIEA & SI: Conception, study design, drafting the manuscript, approval of the final version to be published.

SA & HZ: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

FK & UUS: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Havens M, Peetz B, Do S, Cooper Z, Kelly E, Askari R, et al. The excess morbidity and mortality of emergency general surgery. J Trauma Acute Care Surg 2015; 78: 306–311. https://doi.org/10.1097/ta.0000000000000517
2. Chandra A, Mangam S, Marzouk D. A review of risk scoring systems utilised in patients undergoing gastrointestinal surgery. J Gastrointest Surg 2009; 13(8): 1529-1538. https://doi.org/10.1007/s11605-009-0857-z
3. Barnett S, Moonesinghe R. Clinical risk scores to guide perioperative management. Postgrad Med J 2011; 87(1030): 535-541. https://doi.org/10.1136/pgmj.2010.107169
4. Prytherch R, Ridler M, Beard D, Earnshaw J. A model for national outcome audit in vascular surgery. Eur J Vasc Endovasc Surg. 2001; 21: 477–483. https://doi: 10.1053/ejvs.2001.1369
5. Dutta S, Horgan G, McMillan C. POSSUM and its related models as predictors of postoperative mortality and morbidity in patients undergoing surgery for gastro-oesophageal cancer: a systematic review. World J Surg. 2010; 34:2076–2082. https://doi: 10.1007/s00268-010-0685-z.
6. Whiteley S, Prytherch R, Higgins B, Weaver C, Prout G. An evaluation of the POSSUM surgical scoring system. Br J Surg. 1996; 83: 812–815. https://doi: 10.1002/bjs.1800830628.
7. Wang H, Wang H, Chen T, Liang X, Song Y, Wang J. Evaluation of the POSSUM, P-POSSUM and E-PASS scores in the surgical treatment of hilar cholangiocarcinoma. World J Surg Oncol. 2014;12:191. https://doi:10.1186/1477-7819-12-191
8. Leung E, McArdle K, Wong LS. Risk-adjusted scoring systems in colorectal surgery. Int J Surg. 2011; 9(2): 130-135. https://doi:10.1016/j.ijsu.2010.10.016
9. Sangji F, Bohnen D, Ramly P, Velmahos C, Chang C, Kaafarani A. Derivation and validation of a novel physiological emergency surgery acuity score (PESAS). World J Surg. 2017; 41: 1782–1789. https://doi.org/10.1007/s00268-017-3915-9
10. Peponis T, Bohnen JD, Sangji NF, Nandan AR, Han K, Lee J, et al. Does the emergency surgery score accurately predict outcomes in emergent laparotomies?. Surg. 2017; 162: 445-452. https://doi.org/10.1016/j.surg.2017.03.016
11. Han K, Lee M, Achanta A, Kongkaewpaisan N, Kongwibulwut M, Eid I, et al. Emergency Surgery Score accurately predicts the risk of post-operative infection in emergency general surgery. Surg Infect. 2019; 20: 4–9. https://doi.org/10.1089/sur.2018.101
12. Kaafarani A, Napaporn D, Aicher O, Diaz J, O'Meara B, Decker C, et al. Prospective validation of the Emergency Surgery Score (ESS) in emergency general surgery: an EAST Multicenter Study. J Trauma Acute Care Surg. 2020 https://doi.org/10.1097/ta.0000000000002658
13. Nag S, Dembla A, Mahanty R, Kant S, Chatterjee A, Samaddar P, et al. Comparative analysis of APACHE-II and P-POSSUM scoring systems in predicting postoperative mortality in patients undergoing emergency laparotomy. World J Clin Cases. 2019; 7(16): 2227-2237. https://doi.org/10.12998/wjcc.v7.i16.2227
14. Carvalho-E-Carvalho E, DE-Queiroz L, Martins-DA-Costa X, Werneck-Côrtes G, Pires-Rodrigues V. The applicability of POSSUM and P-POSSUM scores as predictors of morbidity and mortality in colorectal surgery. Rev Col Bras Cir. 2018; 45(1): e1347. doi:10.1590/0100-6991e-20181347
15. González-Martínez S, Martín-Baranera M, Martí-Saurí I, Borrell-Grau N, Pueyo-Zurdo JM. Comparison of the risk prediction systems POSSUM and P-POSSUM with the Surgical Risk Scale: A prospective cohort study of 721 patients. Int J Surg. 2016; 29: 19-24. https://doi:10.1016/j.ijsu.2016.03.005
16. Jha K, Sibakoti C, Devkota H. Evaluation of P-POSSUM Scoring System in Patients Undergoing Emergency Laparotomy. Med J Shree Birendra Hospital. 2017; 17(2): 28-36. doi: http://doi.org/10.3126/mjsbh.v16i2.17714
17. Christou D, Naar L, Kongkaewpaisan N, Alexandros T, Panagiotis S, Andreas T et al. Validation of the Emergency Surgery Score (ESS) in a Greek patient population: a prospective bi-institutional cohort study. Eur J Trauma Emerg Surg. 2022; 48(2): 1197-1204. https://doi:10.1007/s00068-021-01734-9.
18. Nandan R, Bohnen D, Sangji F, Peponis T, Han K, Yeh D, et al. The Emergency Surgery Score (ESS) accurately predicts the occurrence of postoperative complications in emergency surgery patients. J Trauma Acute Care Surg. 2017; 83(1): 84-89. https://doi.org/10.1097/ta.0000000000001500
19. Kongkaewpaisan N, Lee M, Eid A, King D, Kongwibulwut M, Han K, Saillant N, et al. Can the emergency surgery score (ESS) be used as a triage tool predicting the postoperative need for an ICU admission?. Am J Surg. 2019; 217(1): 24-28. https://doi.org/10.1016/j.amjsurg.2018.08.002
20. Ngulube A, Muguti G, Muguti E. Validation of POSSUM, P-POSSUM and the surgical risk scale in major general surgical operations in Harare: A prospective observational study. Ann Med Surg. 2019; 41: 33-39. https://doi:10.1016/j.amsu.2019.03.007